U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SCIENCE AND TECHNOLOGY

TECHNICAL EXPERTS PANEL

PUBLIC MEETING OF TECHNICAL EXPERTS TO DISCUSS PRELIMINARY DATA ON COOLING WATER INTAKE STRUCTURE TECHNOLOGIES AT EXISTING FACILITIES AND THEIR COSTS

May 23, 2001 at the Crystal City Marriott
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DRAFT

PRELIMINARY DATA ANALYSES USING RESPONSES FROM THE DETAILED INDUSTRY QUESTIONNAIRE: PHASE II COOLING WATER INTAKE STRUCTURES (JANUARY 2000)

Prepared for the May 23, 2001 Public Meeting of Technical Experts to Review EPA's Preliminary Data on Cooling Water Intake Structure Technologies in Place at Existing Facilities and Their Costs

May 2001

U.S.EPA Office of Science and Technology
Engineering and Analysis Division

Purpose of This Draft Report

The U.S. Environmental Protection Agency will conduct a public meeting of technical experts on May 23, 2001, to review the Agency's preliminary data on cooling water intake structure technologies that are in place at existing facilities and the costs associated with the use of available technologies for reducing impingement and entrainment. The purpose of this meeting is to elicit individual comments from the technical experts. The topics for discussion are as follows: there may be occasions when a facility needs to reduce impingement or entrainment of aquatic organisms, on those occasions, what are the technologies that might be used and what are the costs and advantages or limitations associated with their use?

This draft report contains the results of preliminary analyses to determine what cooling water intake structure and cooling system technologies are in place at existing facilities. In a separate report, EPA will provide preliminary information on the costs associated with the use of available technologies for reducing impingement and entrainment.

Background Information

In January 2000, EPA distributed a survey questionnaire, titled *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures,* to a sample of facilities including traditional steam electric utilities, steam electric nonutility power producers, and manufacturers that use cooling water. Manufacturers surveyed included facilities from the paper and allied products, chemical and allied products, petroleum and coal products, and primary metals sectors. Of the 1,291 questionnaires mailed, EPA received back a total of 1,277. This represents a return rate of over 98 percent.

EPA believes that 955 of the surveyed facilities are potentially within the scope of regulations for cooling water intake structures at existing facilities because they have: 1) an intake structure that withdraws water for cooling purposes from a water of the U.S.; and 2) a National Pollutant Discharge Elimination System (NPDES) permit issued under section 402 of the Clean Water Act. Information was collected from these 955 facilities to characterize the type and nature of facilities using cooling water, specific uses of cooling water, design and configuration of cooling water systems and cooling water intake structures, types of technologies being used, and whether the facilities had previously evaluated the environmental impacts of their cooling water intake structures.

EPA has developed an electronic database containing the responses received from this survey and is continuing to conduct a quality assurance and quality control (QA/QC) review of the database. These data are appropriate for use in preliminary analyses and to identify needs for further research and analyses.

This draft report contains preliminary data analyses from existing utility and non-utility power producers. EPA focused its analysis on these facilities as, under the terms of the amended consent decree in Riverkeeper v. Whitman, the minimum set of facilities for which EPA must propose regulations by February 28, 2002, includes existing utility and non-utility power producers whose flow levels exceed a minimum to be determined by EPA.

Data Analysis

EPA received questionnaires from a sample of 250 out of 878 traditional utilities and a sample of 42 out of 107 non-utilities identified as potentially within the scope of cooling water intake structure regulations for existing facilities. They were identified as potentially within scope of cooling water intake structure regulations for existing facilities because they withdraw waters of the United States for cooling and have an NPDES permit. The summary tables in this report are based on two preliminary data sets. The first preliminary data set includes responses from 204 traditional utility plants and 29 non-utility power producer plants. Some of the questionnaires (46 utility plants and 13 non-utility power producer plants) were not used for these analyses because responses are still being clarified or corrected by calling respondents or making independent checks. Tables derived from this data set are denoted with an asterisk (*) after the title.

The second preliminary data set is based on responses from 250 traditional utility facilities and 42 non-utility power producer plants. The data in this set are still being verified and therefore, may still contain some inaccurate information. Tables developed with this second set of data are denoted with a double asterisk (**) after the title.

EPA used these preliminary data sets and applied weighting factors derived for each of the facilities based on the survey sample sizes and results to develop draft national estimates of the number of facilities, cooling water systems, and cooling water intake structures.

Table 1. Estimated Distribution of Number of Facilities by the Two Industry Groups and the Corresponding Sample Sizes *

Description: This analysis provides national estimates of the ***number of existing facilities*** in the traditional utility and non-utility power producer industry categories that are potentially in scope and therefore may be subject to the Phase II rule for cooling water intake structures. This analysis does not exclude any facilities that meet a threshold based on total intake flow or a percentage of water withdrawn for cooling purposes.

Industrial Category	Estimated Number of Facilities at National Level	# Respondents (Questionnaires) Used in Developing National Estimates	
		Data Set 1	Data Set 2
Traditional Utilities	566	204	250
Nonutility Power Producers	111	29	42

Total	677	233	292

Table 2. Estimated Distribution of the Number of Facilities by the Number of Cooling Water Systems and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** that have one, two, or more cooling water systems (CWSs) in the traditional utility and non-utility power producer industry categories.

Number Cooling Water Systems	Traditional Utilities		Non-utility Power Producers	
	Estimated Number Facilities	Percent	Estimated Number Facilities	Percent
1	460	81.3	88	79.3
2	83	14.7	19	17.1
3 or More	23	4	4	3.6
Total	566	100	111	100

Table 3. Estimated Distribution of the Number of Facilities by Number of Cooling Water Intake Structures and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** that have one, two, or more cooling water intake structures (CWISs) in the traditional utility and non-utility power producer industry categories.

Number of CWIS	Traditional Utilities		Non-utility Power Producers	
	Estimated Number of Facilities	Percent	Estimated Number of Facilities	Percent
1	408	72.1	83	74.8
2	113	20	24	21.6
3	32	5.7	4	3.6
4 or More	13	2.3	0	0
Total	566	100	111	100

Table 4. Estimated Distribution of Number of Facilities by Sources of Surface Water and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and non-utility power producer industry categories that withdraw water for cooling purposes from the following surface water sources: (a) non-tidal rivers/streams/tidal rivers only, (b) lakes, ponds, or reservoirs only, (c) estuaries or oceans only, (d) combinations of a, b, and c, or (e) none of the above.

Source of Surface Water		Traditional Utilities		Non-utility Power Producers	
		Estimated Number of Facilities	Percent	Estimated Number of Facilities	Percent
A	Non-tidal River, Stream, Tidal River Only	339	59.9	57	51.4
B	Lake, Pond, or Reservoir Only	136	24	18	16.2
C	Estuary or Ocean Only	61	10.8	32	28.8
Combinations of A, B, & C		22	3.9	4	3.6
None of the above		8	1.4	0	0
Total		566	100	111	100

Table 5. Estimated Distribution of Number of CWISs by Sources of Surface Water and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of cooling water intake structures*** at facilities in the traditional utility and non-utility power producer industry categories that withdraw water for cooling purposes from the following surface water sources: (a) non-tidal rivers/streams/tidal rivers only, (b) lakes, ponds, or reservoirs only, (c) estuaries or oceans only, (d) combinations of a, b, and c, or (e) none of the above.

Source of Surface Water		Traditional Utilities		Non-utility Power Producer	
		Estimated Number CWISs	Percent	Estimated Number CWISs	Percent
A	Non-tidal River/Stream/Tidal River Only	478	59.7	71	49.7
B	Lake, Pond, or Reservoir Only	180	22.5	18	12.6
C	Estuary or Ocean Only	114	14.2	50	35
Combinations of A, B, and C		16	1.9	4	2.8
None of the Above		13	1.6	0	0
Total		801	100	143	100

Table 6. Estimated Distribution of Cooling Water Intake System Design Through-Screen (or Through-Technology) Velocities for Traditional Utilities and Non-utility Power Producers **

Description: This analysis provides a national estimate of the ***number and percent of cooling water intake structures (CWISs)*** that fall within a range of velocities at existing facilities in the traditional utility and non-utility power producer industry categories.

Velocity (ft/sec)	Traditional Utilities	
	Estimated Number CWISs	Percent of CWISs
0 - 0.5	144	17.2
0.5 - 1	181	21.6
1 - 2	299	35.7
2 - 3	155	18.5
3 - 5	39	4.7
5 - 7	6	0.7
> 7	14	1.7
Total	838	100
Velocity (ft/sec)	**Non-utility Power Producers**	
	Estimated Number CWISs	**Percent of CWISs**
0 - 0.5	33	23.6
0.5 - 1	22	16.2
1 - 2	35	25.1
2 - 3	37	26.4
3 - 5	0	0
5 - 7	7	4.7
> 7	6	4
Total	140	100

Note: For facilities with multiple CWISs, the sample weight for each CWIS is assumed to be the same as the survey sample weight for that facility. The distribution of non-respondents (i.e., those identified as "Unknown") is assumed to be the same as the distribution of respondents.

Table 7. Estimated Distribution of Facility Total Daily Average Intake Flows (in MGD) for Traditional Utilities and Non-utility Power Producers *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** that fall within a range of daily average intake flow volumes in the traditional utility and non-utility power producer industry categories.

Total Daily Avg. Flow (MGD)	Traditional Utilities			Non-utility Power Producers		
	Estimated Number Facilities	Percent of Facilities	Cumulative Percent	Estimated Number Facilities	Percent of Facilities	Cumulative Percent
0 - 2	22	3.9	3.9	17	15.3	15.3
2 - 25	105	18.6	22.5	20	18.4	33.7
25 - 50	49	8.6	31.1	3	2.4	36.1
50 - 100	73	12.9	44.0	10	9.3	45.4
100 - 250	84	14.8	58.8	16	14.7	60.1
250 - 500	109	19.2	78.0	16	14.7	74.8
500 - 750	39	7.0	85.0	25	22.6	97.4
750 - 1000	34	6.1	91.1	3	2.6	100
> 1000	51	9.0	100	0	0	100
Total	566	100	-	110	100	-

Table 8-1. Estimated Distribution of Number of Facilities by Average of CWIS Operating Days for Each Year *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and nonutility power producer industry categories whose average of all cooling water intake structures shows that they (a) operate greater than, or equal to, 180 days per year or (b) operate less than 180 days per year. Data is provided for each of three years (1996, 1997, and 1998).

Operating Days	Traditional Utilities						Nonutility Power Producers					
	Year 1996		Year 1997		Year 1998		Year 1996		Year 1997		Year 1998	
	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent
≥180 days	442	78.1	441	77.9	444	78.4	85	76.6	86	77.5	88	79.3
<180 days	79	14.0	80	14.1	74	13.1	15	13.5	19	17.1	17	15.3
Unknown	45	8.0	45	8.0	48	8.5	11	9.9	6	5.4	6	5.4
Total	566	100	566	100	566	100	111	100	111	100	111	100

Table 8-2. Estimated Distribution of Number of Facilities by at Least One CWIS Operating Days for Each Year *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and nonutility power producer industry categories that (a) operate at least one cooling water intake structure greater than, or equal to, 180 days per year or (b) operate all cooling water intake structures less than 180 days per year. Data is provided for each of three years (1996, 1997, and 1998).

Operating Days	Traditional Utilities						Nonutility Power Producers					
	Year 1996		Year 1997		Year 1998		Year 1996		Year 1997		Year 1998	
	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent	Est. No. of Facilities	Percent
≥180 days	451	78.1	448	79.2	448	79.2	85	76.6	86	77.5	88	79.3
<180 days	70	14.4	73	12.9	70	12.4	15	13.5	19	17.1	17	15.3
Unknown	45	8	45	8	48	8.5	11	9.9	6	5.4	6	5.4
Total	566	100	566	100	566	100	111	100	111	100	111	100

Table 9. Estimated Distribution of Facilities by Major Technology Category and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and non-utility power producer industry categories that employ a technology at their cooling water intake structures from each of the major categories of technologies.

Major Technology Category	Traditional Utilities		Non-utility Power Producers	
	Estimated Number of Facilities	Percent	Estimated Number of Facilities	Percent
Bar Rack/trash Rack	521	92.0	83	74.8
Screening Technologies	527	93.1	81	73.0
Passive Intake Systems	56	9.9	27	24.3
Fish Diversion or Avoidance System	25	4.4	21	18.9
Fish Handling or Return Technologies	146	25.8	18	16.2
None of the Above	8	1.4	0	0
Note: Percent is based on the estimated total number of facilities, which is 566 for traditional utilities and 111 for non-utility power producers.				

Table 10. Estimated Distribution of Number of CWISs by Major Technology Category and the Two Industry Groups *

Description: This analysis provides a national estimate of the ***number and percent of cooling water intake structures*** (CWISs) at facilities in the traditional utility and non-utility power producer industry categories that employ a technology from each of the major categories of technologies.

Major Technology Category	Traditional Utilities		Non-utility Power Producers	
	Estimated Number of CWISs	Percent	Estimated Number of CWISs	Percent
Bar Rack/trash Rack	680	84.9	110	76.9
Screening Technologies	744	92.9	114	79.7
Passive Intake Systems	64	8.0	27	18.9
Fish Diversion or Avoidance System	31	3.9	31	21.7
Fish Handling or Return Technologies	236	29.5	24	16.8
None of the Above	17	2.1	0	0
Note: Percent of CWISs by technology type is based on the total number of estimated CWISs within traditional utilities and non-utility power producers. The total number of estimated CWISs for traditional utilities is 801, and it is 143 for non-utility power producers.				

Table 11. Estimated Distribution of the Number of CWISs by "Water Body Type" and "Major Technology Category" for Each of the Two Industry Groups *

Description: This analysis provides a national estimate of ***the number and percent of cooling water intake structures*** at facilities in the traditional utility and nonutility power producer industry categories that employ a technology from each of the major categories of technologies. The cooling water intake structures are also categorized as to whether they are from facilities that withdraw water for cooling purposes from the following surface water sources: (a) nontidal rivers/streams/tidal rivers only, (b) lakes, ponds, or reservoirs only, (c) estuaries or oceans only, (d) combinations of a, b, and c, or (e) none of the above.

Major Technology Category	Traditional Utilities											
	A		B		C		D		E		F	
	Facilities Withdrawing From Nontidal Rivers/Streams/ Tidal Rivers Only		Facilities Withdrawing From Lakes/Ponds/ Reservoirs Only		Facilities Withdrawing From Estuaries /Oceans Only		Facilities Withdrawing From Combinations of A, B, & C		None of These		Total	
	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent
Bar Rack/trash Rack	450	60.3	167	22.4	106	14.2	15	2	8	1.1	746	100
Screening Technology	451	59.7	169	22.4	106	14	16	2.1	13	1.7	755	100
Passive Intake Systems	39	53.4	26	35.6	0	0	3	4.1	5	6.8	73	100
Fish Diversion or Avoidance System	8	24.2	15	45.5	8	24.2	0	0	2	6.1	33	100
Fish Handling or Return	150	61.5	14	5.7	73	29.9	0	0	5	2	244	100
None of the above	6	54.5	5	45.5	0	0	0	0	0	0	11	100
Intake structure technology	Nonutility Power Producers											
	A		B		C		D		E		F	
	Facilities Withdrawing From Nontidal Rivers/Streams/Tidal Rivers Only		Facilities Withdrawing From Lakes/Ponds/ Reservoirs Only		Facilities Withdrawing From Estuaries /Oceans Only		Facilities Withdrawing From Combinations of A, B, & C		None of These		Total	
	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent	Est. No. CWISs	Percent
Bar Rack/trash Rack	56	48.3	6	5.2	50	43.1	0	0	0	0	116	100
Screening Technology	60	52.6	0	0	50	43.9	0	0	0	0	114	100
Passive Intake Systems	14	51.9	13	48.1	0	0	0	0	0	0	27	100
Fish Diversion or Avoidance System	2	6.5	6	19.4	19	61.3	0	0	0	0	31	100
Fish Handling or Return	13	54.2	0	0	7	29.2	0	0	0	0	24	100
None of the above	0	0	0	0	0	0	0	0	0	0	0	0

Note : There were no facilities that reported that they withdrew from B + C or A+ B + C. The percentages across each row add up to 100 percent.

Table 12. Estimated Distribution of Number of Facilities Having Conducted an Environmental or Technology Study by Industry Group *

Description: This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and non-utility power producer industry categories that have performed any biological studies including discrete or ongoing impingement and/or entrainment monitoring, discrete studies to evaluate the effectiveness of a technology to minimize impingement or entrainment, and Section 316(b) demonstration studies.

Conduct of Any Environmental or Technology Study	Traditional Utilities		Non-utility Power Producers	
	Estimated Number of Facilities	Percent	Estimated Number of Facilities	Percent
Yes	348	61.5	64	57.7
No	218	38.5	47	42.3
Total	566	100	111	100

Table 13. Distribution of Facility Mitigation Activities for Traditional Utilities and Non-utilities **

This analysis provides a national estimate of the ***number and percent of facilities*** in the traditional utility and non-utility power producer industry categories that have carried out any measures to compensate for or to mitigate potential environmental impacts.

Mitigation Measures	Traditional Utilities			Non-utility Power Producers		
	Estimated of Facilities Performing Any Mitigation Alternative	Estimated Number of Facilities	Percent	Estimated of Facilities Performing Any Mitigation Alternative	Estimated Number of Facilities	Percent
Restocking Fisheries	25	3	0.6	10	2	2.2
Maintaining Hatcheries		5	0.9		2	2.2
Habitat Restoration		2	0.3		1	1.0
Designation of Conservation Areas		4	0.7		1	1.0
Other		20	3.5		7	6.1
Total		34	6.0		13	12.5

Note: Some facilities employ more than one mitigation measure. Where this is the case, these facilities have been counted in each mitigation measure category that applies. Thus, the total number of facilities employing the various mitigation measures exceeds the total number of facilities performing mitigation

Table 14. Estimated Cumulative Distribution of Cooling Water System Configurations as a Function of Age for Traditional Utilities and Non-utility Power Producers **

Description: This analysis provides a national estimate for the configuration of ***cooling water systems (CWSs)*** by type as a function of age in the traditional utility and non-utility power producer industry categories. The percent of cooling water systems from the total national estimates that should exhibit each configuration is also provided.

CWS Age (Years)	CWS Configuration	Traditional Utilities	
		Estimated Number CWSs	Percent of CWSs
≤ 5	Total	0	0
≤ 10	Once-through	3	41.7
	Recirculating	5	58.3
	Combination	0	0
	Total	8	100
≤ 15	Once-through	7	33.4
	Recirculating	13	66.6
	Combination	0	0
	Total	20	100
All	Once-through	516	71.4
	Recirculating	168	23.3
	Combination	38	5.3
	Total	722	100
CWS Age (Years)	**CWS Configuration**	**Non-utility Power Producers**	
		Estimated Number CWSs	**Percent of CWSs**
≤ 5	Once-through	2	24
	Recirculating	7	76
	Combination	0	0
	Total	9	100
≤ 10	Once-through	6	32.2
	Recirculating	12	67.8
	Combination	0	0
	Total	18	100
≤ 15	Once-through	11	34.2
	Recirculating	22	65.8
	Combination	0	0
	Total	33	100
All	Once-through	91	69.5
	Recirculating	40	30.5
	Combination	0	0
	Total	131	100
Note: For facilities with multiple CWSs, the sample weight for each CWS is assumed to be the same as the survey sample weight for that facility. The distribution of non-respondents (i.e., those identified as "Unknown" above) is assumed to be the same as the distribution of respondents.			

Table 15. Estimated Distribution of Cooling Water System Configuration as a Function of Water Body Type for Traditional Utilities and Non-utility Power Producers **

Description: This analysis provides a national estimate of ***number and percent of cooling water systems*** in the traditional utility and non-utility power producer industry categories that have a cooling water system (CWS) configuration in each water body type.

Water Body Type	CWS Configuration	Traditional Utilities	
		Estimated Number CWSs	Percent of CWSs
Non-tidal River/Stream/ Tidal River	Once-through	307	62.5
	Recirculating	155	31.6
	Combination	29	5.9
	Total	491	100
Lake/Pond/Reservoir	Once-through	149	81.5
	Recirculating	22	11.9
	Combination	12	6.6
	Total	183	100
Estuary/Ocean	Once-through	72	93.9
	Recirculating	2	2.2
	Combination	3	3.9
	Total	77	100
All	Once-through	516	71.4
	Recirculating	168	23.3
	Combination	38	5.3
	Total	722	100
Water Body Type	**CWS Configuration**	**Non-utility Power Producers**	
		Estimated Number CWSs	**Percent of CWSs**
Non-tidal River/Stream/ Tidal River	Once-through	44	62
	Recirculating	27	38
	Combination	0	0
	Total	71	100
Lake/Pond/Reservoir	Once-through	4	28.1
	Recirculating	11	71.9
	Combination	0	0
	Total	15	100
Estuary/Ocean	Once-through	44	100
	Recirculating	0	0
	Combination	0	0
	Total	44	100
All	Once-through	91	69.5
	Recirculating	40	30.5
	Combination	0	0
	Total	131	100

Note: For facilities with multiple CWSs, the sample weight for each CWS is assumed to be the same as the survey sample weight for that facility. The distribution of non-respondents (i.e., those identified as “Unknown”) is assumed to be the same as the distribution of respondents. Some CWS are associated with multiple water body types (for example, river and lake). Where this is the case, these CWSs have been counted separately in each water body category that applies. These CWS have been counted only once in the “All “ water body category.

Table 16. Estimated Distribution of Cooling Water Intake Structure Arrangements for Traditional Utilities and Non-utility Power Producers **

Description: This analysis provides a national estimate for the ***number and percent of facilities and cooling water intake structures*** in the traditional utility and non-utility power producer industry categories that have each intake arrangement.

Estimated Number of Facilities	Estimated Number of CWISs	Traditional Utilities				
		Intake Arrangement	Estimated Number Facilities	Percent of Facilities	Estimated Number CWISs	Percent of CWISs
566	837	Canal/Channel	172	30.4	253	30.2
		Bay/Cove	48	8.4	60	7.2
		Shoreline	392	69.4	505	60.4
		Offshore	56	10.0	90	10.8
		Total	668	118.2	908	108.6
Estimated Number of Facilities	Estimated Number of CWISs	Non-utility Power Producers				
		Intake Arrangement	Estimated Number Facilities	Percent of Facilities	Estimated Number CWISs	Percent of CWISs
111	139	Canal/Channel	9	8.0	14	10.3
		Bay/Cove	20	18.2	24	17.1
		Shoreline	75	67.7	97	69.4
		Offshore	27	24.1	33	24.0
		Total	131	118.0	168	120.8
Notes: Some facilities/CWISs are associated with multiple intake arrangements (for example, canal and shoreline). Where this is the case, these facilities/CWISs have been counted in each intake category that applies. The percent of facilities/CWISs is based on total number of facilities/CWISs; since some facilities/CWISs have multiple intake arrangements, the total percentages may exceed 100%.						

Table 17. Estimated Distribution of Facility Intake Arrangements as a Function of Water Body Type for Traditional Utilities and Non-utility Power Producers **

Description: This analysis provides a national estimate for the ***number and percent of facilities*** in the traditional utility and non-utility power producer industry categories that have an intake arrangement in each water body type.

Water Body Type	Traditional Utilities			
	Estimated Number Facilities	Intake Arrangement	Estimated Number Facilities	Percent of Facilities
Non-tidal River/ Stream/Tidal River	372	Canal/Channel	85	22.8
		Bay/Cove	18	4.7
		Shoreline	281	75.5
		Offshore	35	9.3
		Total	419	112.3
Lake/Pond/ Reservoir	155	Canal/Channel	72	46.4
		Bay/Cove	26	16.7
		Shoreline	96	62.1
		Offshore	22	14.0
		Total	216	139.2
Estuary/Ocean	61	Canal/Channel	31	50.4
		Bay/Cove	10	15.8
		Shoreline	30	49.3
		Offshore	2	3.9
		Total	73	119.4
All	566	Canal/Channel	172	30.4
		Bay/Cove	48	8.4
		Shoreline	392	69.4
		Offshore	56	10.0
		Total	668	118.2
Water Body Type	**Non-utility Power Producers**			
	Estimated Number Facilities	**Intake Arrangement**	**Estimated Number Facilities**	**Percent of Facilities**
Non-tidal River/ Stream/Tidal River	63	Canal/Channel	8	12.3
		Bay/Cove	9	14.4
		Shoreline	46	72.6
		Offshore	8	13.0
		Total	71	112.3
Lake/Pond/ Reservoir	15	Canal/Channel	0	0.0
		Bay/Cove	0	0.0
		Shoreline	6	39.7
		Offshore	9	60.3
		Total	15	100.0
Estuary/Ocean	33	Canal/Channel	1	3.5
		Bay/Cove	14	41.6
		Shoreline	26	79.2
		Offshore	7	20.8
		Total	48	145.1
All	111	Canal/Channel	9	8.0
		Bay/Cove	20	18.2
		Shoreline	75	67.7
		Offshore	27	24.1
		Total	131	118.0

Notes: Some facilities are associated with multiple intake arrangements (for example, canal and shoreline) and/or water body types (for example, river and lake). Where this is the case, these facilities have been counted separately in each intake and/or water body category that applies. The total numbers of facilities reported for the "All" water body categories represent the total universe of facilities. The percent of facilities is based on total number of facilities on that water body type; since some facilities have multiple intake arrangements, the total percentages may exceed 100%.

DRAFT
INITIAL COST ESTIMATES

Prepared for the May 23, 2001 Public Meeting of Technical Experts to Review EPA's Preliminary Data on Cooling Water Intake Structure Technologies in Place at Existing Facilities and Their Costs

May 17, 2001

USEPA Office of Science and Technology
Engineering and Analysis Division

A. PURPOSE OF THIS DRAFT REPORT

The U.S. Environmental Protection Agency (EPA) will conduct a public meeting of technical experts on May 23, 2001, to review the Agency's preliminary data on cooling water intake structure technologies that are in place at existing facilities and the costs associated with the use of available technologies for reducing impingement and entrainment. The purpose of this meeting is to elicit individual comments from the technical experts. The topics for discussion are as follows: there may be occasions when a facility needs to reduce impingement or entrainment of aquatic organisms, on those occasions, what are the technologies that might be used and what are the costs and advantages or limitations associated with their use?

This draft report contains the results of preliminary analyses to estimate the cost of cooling water intake structure and cooling system technologies in place at existing facilities. In a separate report, EPA will provide information on what cooling water intake structure and cooling system technologies are in place at existing facilities based on the Agency's preliminary data analyses using responses from the Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures (January 2000).

B. DRAFT MODEL PLANT COOLING WATER INTAKE STRUCTURE COSTS

Table 1 – Summary of Draft Model Plant Cooling Water Intake Structure Costs

Description: The table below presents the capital and net increase in annual operation and maintenance (O&M) and annual costs for selected cooling system technologies installed at facilities with existing once-through cooling systems with low, medium, and high cooling water flows.

Cooling System	CWIS Improvements	Cooling Flow[a] (gpm)	Intake Flow (gpm)	Capital Cost	Net O&M Cost[b] Net / Baseline	Net Annual Cost[bc] Net / Baseline
Once-through	**None Baseline Scenario**	17,400	17,400	$0	$0 / $147,000	$0 / $147,000
		104,000	104,000	$0	$0 / $880,000	$0 / $880,000
		347,000	347,000	$0	$0 / $2,935,000	$0 / $2,935,000
Once-through	**Passive Screens** Intake Velocity = 0.5 fps.	17,400	17,400	$160,000	$0	$13,000
		104,000	104,000	$808,000	$0	$65,000
		347,000	347,000	$2,745,000	$0	$221,000
Once-through	**Traveling Screens with Fish Baskets** Intake Velocity = 0.5 fps	17,400	17,400	$442,000	$19,000	$55,000
		104,000	104,000	$1,740,000	$56,000	$196,000
		347,000	347,000	$5,759,000	$193,000	$657,000
Wet Tower	**None**	17,400	1,740	$1,230,000	$173,000	$272,000
		104,000	10,400	$6,790,000	$842,000	$1,390,000
		347,000	34,700	$21,400,000	$2,540,000	$4,270,000

Cooling System	CWIS Improvements	Cooling Flow[a] (gpm)	Intake Flow (gpm)	Capital Cost	Net O&M Cost[b] Net / Baseline	Net Annual Cost[bc] Net / Baseline
Wet Tower	**Passive Screens**	17,400	1,740	$1,270,000	$173,000	$275,000
	Intake Velocity = 0.5 fps	104,000	10,400	$6,916,000	$842,000	$1,400,000
		347,000	34,700	$21,740,000	$2,540,000	$4,300,000
Wet Tower	**Traveling Screens with Fish Baskets**	17,400	1,740	$1,340,000	$179,000	$389,000
		104,000	10,400	$7,070,000	$858,000	$1420,000
	Intake Velocity = 0.5 fps	347,000	34,700	$22,100,000	$2,570,000	$4,350,000
Dry Tower	**None**	17,400 Equivalent	348	$4,130,000	$863,000	$1,190,000
		104,000 Equivalent	2,080	$21,500,000	$4,230,000	$5,970,000
		347,000 Equivalent	6,940	$72,600,000	$9,700,000	$15,500,000

[a] Equipment was sized for the cooling water flow shown. These flows represent the once-through or recirculating flow or, in the case of dry towers they represent the equivalent cooling water flow rate for a similarly sized steam turbine power plant. These flows are equivalent to 25 million gallons per day (MGD), 150 MGD and 500 MGD.
[b] All costs are net values in which the O&M costs of the baseline technology have been subtracted. For the baseline facility, the baseline costs for the existing cooling system are also shown after the "/" .
[C] Annual costs are the sum of annual O&M costs and the annualized capital cost assuming a 30 year amortization period and a discount rate of 7%.

Basis for Cost Estimates

Table 1 provides EPA's draft initial estimate of the costs that would be incurred by a facility with an existing once-through cooling system if it were required to modify or replace the existing cooling system with one of the selected technology scenarios. Within each technology scenario, costs are presented for cooling systems with three different cooling water flows (or equivalent measures) representing small, medium, and large facilities. The data presented in the table includes the net increase in capital, annual O&M, and total annual cost for the selected technology scenarios as compared to the costs for an existing once-through cooling system. Net costs are derived by subtracting the estimated costs for the baseline once-through cooling system that has the same cooling flow or equivalent. Annual costs are the sum of annual O&M costs and the annualized capital cost. The annualized capital costs (not shown separately) were derived from the capital costs using an amortization period of 30 years and a discount rate of 7%. The salvage value of the existing once-through cooling system was assumed to offset capital costs for the resized water intake system, and therefore, the capital costs did not require adjustment on a net basis. The technologies are presented in the order of increasing costs. Note that for power plants these comparative costs do not include consideration of the energy penalty associated with changes in the turbine exhaust pressure that may occur when different types of cooling systems are used. In general, this penalty varies for different regions and times of year.

Three cooling water flow rates were selected to represent low, medium, and high cooling water flow values. The values are roughly equivalent to the 25th, 50th, and 75th percentile of intake flows from utilities and non-utilities, as indicated by data from the preliminary Detailed Technical Questionnaire database. For this initial analysis, no attempt was made to stratify these flow data according to once-through versus recirculating systems. The flow values picked are 25 MGD, 150 MGD, and 500 MGD, which are equivalent to 17,400 gpm, 104,000 gpm, and 347,000 gpm, respectively. It was assumed that the cooling water flow rate through the condenser would be equal for both once-through systems and recirculating wet towers. Additionally, the dry cooling costs correspond to systems that would have equivalent power generating capacity to wet systems using the selected cooling water flows.

With the exceptions described below (*e.g.*, retrofit cost assumptions), EPA developed all of these draft initial cost estimates using the cost data presented in the Economic and Engineering Analysis of Proposed 316(b) New Facility Rule, August 2000 (EEA).

Technology Selection

The technologies selected for these draft initial cost estimates represent the spectrum of costs associated with varying degrees of cooling system modification and varying degrees of cooling water intake structure (CWIS) modifications, where applicable. The costs represent an estimate of the financial impact of applying the different technology scenarios to an existing once-through cooling system. The technologies selected are limited to only those for which EPA has already generated cost estimates.

The alternative cooling system technologies include:

- None (once-through as baseline)
- Wet towers
- Dry towers

The CWIS improvements include:

- None
- Passive/wedge wire screens
- Traveling screens with fish baskets

Draft initial cost estimates for these CWIS improvements are included for both the once-through systems and for the intake structure for the reduced intake flow needed for wet towers. These technologies were selected to represent varying degrees of costs representing low, medium, and high values. These CWIS technologies, however, do not represent the only technologies EPA is evaluating. Additional technologies being considered but not shown in these estimates include:

- Gunderbooms
- Barrier nets
- Light/sound barriers
- Fish return systems
- Variable speed pumps

Cost estimates for these additional CWIS technologies are still under development.

<u>Technology Summary Description</u>

The following assumptions were used in the development of these draft initial cost estimates.

<u>Baseline Scenario - Once-through Cooling</u>

This scenario represents the baseline existing facility to which the draft costs of all technology modifications were compared. The draft costs for the baseline system are estimated with the impact on net costs in mind. Since the technology is already in-place, no capital costs were estimated. Any salvage value of equipment no longer needed in the alternative cooling system scenarios, such as large volume pumps, was assumed to offset the cost for new smaller volume pumps and piping.

Once-through O&M costs are based on the cooling water pumping energy requirement, since the surface water pumping requirement would be greatly reduced with installation of cooling towers. Note that the cooling tower O&M cost estimates include the recirculation pumping costs. The once-through pumping costs are based on the selected cooling water flows and the following assumptions:

- pumping head = 50 ft.
- energy cost = $0.08/KWh
- pump efficiency = 70%
- operating time = 7860 hrs/yr.

These annual O&M pumping costs are deducted from the annual costs for alternative technologies to obtain net costs for the alternative technologies. For wet cooling towers, only 90% of this cost is deducted, since, as described below, an estimated 10% of the original withdrawal is still pumped as make-up water.

Once-through with Passive Screens

The addition of passive screens represents a medium cost with respect to CWIS improvements for which EPA has developed draft cost estimates. The screens are sized for an intake velocity of 0.5 fps. The capital cost estimates used are based on new facilities and therefore an additional cost equal to 30% of the capital cost was added to account for modifications to the existing structure associated with retrofitting. Since the screens are cleaned using an air backwash system, there is no appreciable increase in O&M costs over the baseline system. Since backwash debris must be swept away naturally, these screens may not be appropriate for locations with low water velocities. Since the low cooling flow value was within the cost curve range for the largest unit costed, 10 ft wide traveling screens were used for all three flow volumes. For the two higher flows >26,000 gpm (high end of the cost curve), costs were developed for four and 13 parallel 10 ft wide units. The cost data in Chart 30 of the EEA was used.

Once-through with Traveling Screens with Fish Baskets

The addition of traveling screens with fish handling features (a.k.a. fish baskets) represents a high cost with respect to CWIS improvements for which EPA has developed draft cost estimates. The traveling screens with fish baskets are sized for an intake velocity of 0.5 fps. The capital costs are based on new facilities and, therefore, an additional cost equal to 30% of the capital cost was added to account for modifications to the existing structure associated with retrofitting. Since the low cooling flow value was within the cost curve range, 14 ft wide traveling screens were used for all three flow volumes. For the high flow >104,000 gpm (high end of the cost curve), costs were developed for two parallel 14 ft wide units. The cost data in Chart 36 and 41 of the EEA were used.

Wet Towers without CWIS Improvements

The use of wet towers results in substantial reduction in, but not the elimination of, cooling water requirements and therefore represents a medium level of improvement to the cooling system itself for which EPA has developed draft cost estimates. The cooling system technology selected consists of a recirculating wet tower constructed of redwood with an approach of 10 ^{o}F. Redwood construction was selected because it corresponds to the median capital cost for cooling towers made from different building materials (see Chart 8 of EEA). EPA recognizes that redwood is not commonly used as a tower construction material and chose redwood towers simply because they represent the median cost.

Wet towers still need make-up water to account for evaporation, drift and blowdown. The make-up flow volume is assumed to be equal to 10% of the recirculating flow, resulting in intake flows of 1,740 gpm, 10,400 gpm, and 34,700 gpm for the small, medium, and large facilities, respectively. An intake flow factor of 10% instead of the estimated average value of 5% was chosen to account for overall variations. Thus, a 10% factor is considered a conservative estimate (i.e., the estimated intake volumes and CWIS costs for wet towers are close to the high end of what would be expected). The new intake system will require modification to accommodate the reduced flow. It is assumed that the salvage value of the existing intake equipment such as pumps (currently sized for 10 times the reduced intake volume) will offset the capital cost for the much smaller equipment required for the modified intake system. The cost estimates include the treatment and discharge of cooling tower blowdown (Scenario 1 from EEA). This technology scenario does not include any CWIS improvements to the surface water intake and therefore there are no CWIS costs. Note that the estimated O&M costs include the recirculating cooling water pumping, which is sized for the cooling needs of the plant, not the intake/makeup water requirements. The costs for the wet towers were derived from data in Charts 10 and 19 of the EEA.

Wet Towers with Passive Screens

The addition of passive screens represents a medium cost with respect to CWIS improvements for the intake system for wet towers. Wet towers with passive screens consist of the same recirculating redwood wet tower as described above. This scenario uses the same passive screen technology (as described for the once-through system above) as part of the make-up water intake structure. The capital costs are based on new facilities and therefore an additional cost equal to 30% of the capital cost was added to account for modifications to the existing structure associated with retrofitting. The costs for the systems with low, medium, and high intake flows were based on 2-ft wide, 10-ft wide, and 10-ft wide screens, respectively. The cost for the large facility was based on two parallel 10-ft wide screens.

Wet Towers with Traveling Screens with Fish Baskets

The addition of traveling screens with fish baskets represents the high cost with respect to CWIS improvements for the intake system for wet towers. Wet towers with traveling screens with fish baskets consist of the same recirculating redwood wet tower as described above. This scenario uses the same traveling screen with fish baskets technology (as described for the once-through system above) as part of the make-up water intake structure. The capital costs are based on new facilities and therefore an additional cost equal to 30% of the capital cost was added to account for modifications to the existing structure associated with retrofitting. The costs for the system with low, medium, and high intake flows were based on 2-ft wide, 10-ft wide, and 14-ft wide screens, respectively.

Dry Cooling

A dry system nearly eliminates the need to withdraw surface water and, therefore, represents the highest level of improvements to the cooling system itself. Dry cooling involves the replacement of the existing surface condenser with an air cooled condenser. The draft costs presented are for cooling systems sized for power plants that would otherwise use comparable volumes of cooling water as the three flow rates used to estimate costs for the water-based cooling systems. The conversion factor used is for a steam turbine power plant using a cooling factor of 12,000 BTUs/ton and 3 gpm cooling water/ton for wet systems and 15,000 BTUs/ton for dry systems.

The make-up water requirements are very low (EPA estimates 2% of equivalent flow) and, therefore, EPA assumes the pumping and CWIS cost (if any is needed) will be insignificant compared to the total cost and that the salvage value of the once-through pumping equipment will more than offset any costs for equipment needed to supply this water. As a result, only one dry cooling technology scenario is evaluated.

One cost not addressed for dry cooling installation at existing facilities that previously utilized once-through or recirculating cooling towers is the potential need for replacement turbines. EPA is developing and gathering data to address steam turbine retrofitting costs and needs. This potential cost is not included in the estimates presented above and could represent a significant capital cost incurrence.

C. DRAFT RESTORATION COST ESTIMATES

The following draft initial cost estimates for restoration are drawn from materials EPA prepared prior to proposal of regulations for cooling water intake structures at new facilities (65 Fed.Reg. 49060).

Historically, restoration measures, as used in the context of section 316(b) determinations, include practices that seek to compensate for the fish or aquatic organisms killed, or enhance the aquatic habitat in the waterbody in which a cooling water intake structure operates. Examples of restoration measures that have been included as conditions of permits include creating, enhancing, or restoring wetlands; developing or operating fish hatcheries or fish stocking programs; removing impediments to fish migration; enhancing natural resources in an impacted watershed; and other projects designed to replace fish or restore habitat. Such projects have proven useful in permitting certain cooling water intake structures because they provide a substantial degree of flexibility to the permit writer to address the adverse environmental impact caused by a cooling water intake structure.

According to the National Oceanic and Atmospheric Administration, there are three components to a restoration measure being used for mitigation purposes:

- restoration of the injured habitat or species to baseline (primary restoration);
- compensation for the interim loss of resources from the time of injury until the resources recover to baseline (compensatory restoration); and
- performance of the damage assessment (NOAA, 1999).

EPA developed draft initial cost estimates for two primary restoration approaches. The first approach is the restoration or creation of habitat. The purpose of habitat restoration is to restore all or some ecological functions, such as increased forage or protective cover, to a currently degraded habitat. This is typically accomplished through reseeding, replanting, removal of invasive species, physical modification of the site, or some combination of these efforts. Habitat creation, rather than restoring an existing habitat, involves the direct modification of a site to establish new habitat. This process is similar to site restoration, however, it can involve extensive modification of the site substrate, alteration of site hydrology, and excavation work to modify site topography.

Due to the more extensive reliance on site modification, habitat creation tends to be more costly than the restoration of existing but degraded habitat.

For freshwater rivers, lakes and reservoirs, the most common type of habitat restored is wetlands. For tidal rivers, estuaries, and oceans, there is a greater variety of habitats restored, ranging from salt marshes to oyster reefs.

The second approach to restoration does not restore habitat for the species impacted due to cooling water intake but, instead, mitigates the loss of organisms through restocking. For this analysis, EPA made the conservative assumption that a facility implementing restoration measures would do both habitat restoration and fish restocking.

Habitat Restoration Costs

The cost of a habitat restoration project depends on numerous site-specific factors including the type of habitat being restored, the size of the project, the cost of suitable land, the extent of site preparation needed, and the anticipated survival rate of the restored biota. As a result, habitat restoration project costs are highly site-specific and can vary greatly from project to project. Furthermore, such site-specific conditions and extreme cases cannot be accurately accounted for when developing cost estimates at the national level.

For purposes of costing a habitat restoration project, habitat type (e.g. wetlands, sea grass, reef) and project size are the two key factors that predominately determine costs. Therefore to develop cost estimates for a habitat restoration project, an estimate of the size of the project and habitat is needed.

A habitat equivalency analysis would need to be performed to determine both the type and extent of habitat to be restored. In this type of analysis the first step is to calculate the extent of damage typically in terms of reduced biomass, species diversity and population levels, or loss of benefits derived from the impacted area. Then the per hectare increase in biota that is anticipated from various habitat restoration measures is estimated. Using this information the scope of the restoration project could then be derived.

For purposes of this initial costing exercise, EPA made assumptions as to the required size or type of habitat restoration project that each facility would be likely to undertake. EPA assumed salt marsh, sea grass, and oyster reef restoration are the types of projects used for estuaries, tidal river, and oceans. EPA derived cost estimates for each of these habitats from a literature review of restoration project costs published in the National Oceanic and Atmospheric Administration's *Primary Restoration Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*. The document reported cost information for salt marsh restoration, seagrass restoration, and oyster reef restoration in 1992 dollars on a per hectare basis.

EPA assumed the type of habitat restoration project that would most likely be available for streams, nontidal rivers, lakes, and reservoirs, is wetlands restoration and creation. Given that tidal rivers, estuaries, and coastal water bodies are typically larger in size and more biologically diverse than freshwater rivers, streams, lakes, and reservoirs, EPA assumed that there would be a greater abundance of potential restoration projects available for facilities to consider. Therefore, it was assumed that facilities would choose projects where restoration could be achieved primarily through replanting and reseeding that required little to no construction costs in order to minimize the cost of the restoration measure. The costs for habitat restoration in the salt water habitats are based primarily on replanting or reseeding costs with minimal construction work necessary. The literature reviewed for wetlands creation (NOAA,1996) did include both project size and site preparation cost information.

When developing costs for a potential requirement for restoration at new facilities, EPA anticipated that the average size of most facility restoration projects would be considerably smaller than that of a typical restoration project, which is assumed to be approximately 200 hectares.[1] The reason for this was an assumption that new facilities subject to the requirements of the proposed Section 316(b) New Facility regulations would meet the various proposed limitations for capacity, proportional flow, velocity and use of additional technologies such as fish diversion or return systems. Therefore, to represent the expected small, median, and large project sizes, EPA chose size estimates of 5, 10, and 30 hectares, which are approximations of the lowest, median, and largest project sizes that fall into the first 25th percentile of project sizes in the literature review of wetland restoration projects (NOAA,1996). For an existing facility with much larger intake capacity, the draft costs presented below at Worst Case Scenario for Restoration, below, may be more appropriate.

Furthermore, EPA assumed that on average facilities with larger flows would impinge and entrain a greater number of fish and other aquatic fauna. Therefore, EPA assumed that the lowest, median, and highest flow facilities would require project sizes of 5, 10, and 30 respectively. Table 1 provides these flow rates and the corresponding restoration project size. From this assumed corresponding relationship between flow and project size, EPA developed an equation which could be used for estimating the project size for the rest of the facilities conducting habitat restoration.

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[1] Based on a literature review of wetland restoration/creation case studies (NOAA, 1996), a typical project size was estimated to be 200 hectares.

Table 1. Estimated Relationship Between Facility Flow and Restoration Project Size		
	Facility Flow Rates (gpm)	**Corresponding Project Size**
Smallest	1,700	5 hectares
Median	9,000	10 hectares
Largest	53,000	30 hectares

Equation for relationship between flow (gpm) and project size (ha).

$$-4E\text{-}09 * \text{flow}^{2} + 0.0007 * \text{flow} + 3.766 = \text{project size}$$

EPA used these assumptions and the unit habitat restoration costs reported in the National Oceanic and Atmospheric Administration's *Primary Restoration Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990* to develop the habitat restoration costs reported in Tables 2 and 3.

Table 2. Draft Estimated Restoration Project Costs for Estuaries, Tidal Rivers and Oceans (1992 $)

1992 dollars	**mean$/ha**	**5 ha**	**10 ha**	**30 ha**
Salt Marsh Restoration[1]	$25,559	$127,794	$255,588	$766,763
Sea Grass Restoration[2]	$96,804	$484,019	$968,037	$2,904,112
Oyster Reef Restoration[3]	$6,038	$30,188	$60,376	$181,128
Assuming Equal Probability	$42,800	$214,000	$428,000	$1,284,001
Assuming Equal Probability in 1999$[4]	**$51,000**	**$256,000**	**$512,000**	**$1,537,000**

1. Median cost based upon eight salt marsh replanting and reseeding studies (NOAA, 1996).

2. Sea Grass restoration costs assume an equal probability for both temperate and subtropical sea grass restoration. The median per hectare cost for temperate sea grass is $24,620, based upon five restoration studies. The median cost for (NOAA, 1996).

3. Median cost based upon 15 oyster reef restoration studies (NOAA, 1996).

4. Cost figures were adjusted to 1999 dollars using a 19.7% inflation factor, using the Consumer Price Index.

Table 3. Draft Habitat Restoration Costs (1999$)

Restoration Project Size	**5 ha**	**10 ha**	**30 ha**
Fresh Water Wetland Restoration	$229,000	$388,000	$893,000

Equation for relationship between wetlands restoration/creation project size(ha) and project cost($).[1]

$$56{,}475 * \text{size}^{-0.241} = \text{project cost}$$

1. Equation derived from 15 case studies reported

Project size estimates were based upon the anticipated cooling water intake flow for each facility under consideration as EPA developed proposed regulations for cooling water intake structures at new facilities.

Fish Restocking Costs

Fish restocking can be used as either the primary means of restoration or compensatory restoration purposes during the recovery period for the habitat restoration measure. Facilities may decide to use restocking for primary restoration purposes when a suitable restoration site is not available to them, and when the impingement and entrainment losses primarily affect fish species that can be obtained from fish hatcheries. When habitat restoration is employed facilities will need to restock fish during the initial years following the implementation of the habitat restoration project, while flora and fauna become reestablished at the restoration site.

EPA chose three commonly restocked species: salmon, trout, and bass, to represent the estimated per fish cost for restocking, and assumed that they would be restocked with equal probability on a national scale (i.e. the species specific costs were averaged).

Fish are typically sold on a per-inch basis. Larger fish have a higher survival rate, but are also generally more expensive. As a result, a mixture of juvenile and mature fish are usually used for restocking purposes. EPA chose a restocking mix of 50 percent five inch fish, 30 percent seven inch fish, and 20 percent of the fish at 10 inches. Using national hatchery cost averages for the three representative species, and the assumed stocking mixture, the estimated cost per fish is $1.42 (1999 dollars) (NOAA, 1996).

Typically when fish are restocked, it is for mitigation purposes. Fish are usually restocked on an annual basis (NOAA, 2000), so the total annual number of fish restocked is based on the estimated losses per year. As with habitat restoration, determining the scope of the restocking effort is made difficult by the lack of information concerning new facilities. As a result, EPA took the same approach as with habitat restoration and based the restocking rate on the expected flow for each facility. The range of restocking rates EPA chose is between 25,000 and100,000 fish per year. EPA also selected a travel distance for restocking of 500 miles per trip, and that the number of fish transported per trip was 25,000.[4] Table 4 provides the estimated restocking costs for the representative species and for various restocking rates.

Table 4. Draft Annual Fish Restocking Costs for Restoration Measures (1999$)

Type of Cost	Number of Fish Restocked		
	25k	**50k**	**100k**
Transportation Cost	$700	$1,400	$2,900
Fish Cost*	$35,500	$70,900	$141,900
Total Cost**	**$36,200**	**$72,000**	**$145,000**

*Cost is based on the $1.42 per fish cost.
** Total cost figures have been rounded to the nearest thousand.

When restocking is being used as the only means of restoration, EPA assumed that facilities will continue to restock at the same annual rate. However, when restocking is used for compensatory restoration during the interim recovery period for the habitat, EPA assumed that the rate of restocking will decrease as flora and fauna become established at the site.

Based upon a series of case studies that document the establishment of flora and fauna at the restored site, EPA determined that three to fifteen years was a reasonable recovery period for wetland projects and one to five years for estuary/tidal river projects (NOAA, 1996). Using the documented recovery rate from a restoration project on the Salmon River, EPA developed a habitat recovery equation. Table 5 provides the information from the case study and the resulting equation. This equation was then used to approximate the recovery rate for fish species using the habitat. EPA estimated that facilities could reduce the restocking at an inversely proportionate rate to the recovery of the fish. Because of the more rapid recovery rate of estuarine habitats, EPA assumed that by the second year, the restocking level could be reduced by 40% , by 70% in year three, 90% in year four, and would not be necessary by year five.

Table 5. Recovery Rate Based Upon the Salmon River Restoration Project

Years after project	% recovery of vegetation at site
0	0%
2	31%
10	91%
15*	100%
Equation for the Percentage Recovery forWetland Restoration Projects $((-0.0051*(Year^2))+(0.1416*Year)+0.0193)=\%Recovery$	

* The recovery of the site was monitored for 10 years, so the recovery rate for year 15 was assumed based upon information from other case studies.

Draft Worst-Case Scenario for Restoration

EPA decided to cost a worst-case scenario for a large coal-fired or nuclear power plant with high cooling water flow based on a restoration case study from a large nuclear plant with a large cooling water intake flow. EPA correlated flow, size of restoration project (per hectare), and the unit cost of restoration measures to develop a reasonable estimate of costs for a restoration project on a dollar per gallon per minute ($/gpm) of cooling water flow. EPA used a worst-case cost estimate for fish restocking of 1 million fish per year. Table 6 shows the resulting draft, initial worst-case estimates.

Table 6. Draft Capital and O&M Costs for Restoration Worst-Case Scenarios (1999$)

	Restoration Capital Cost	O&M Cost for Restoration During First Year
Coal-fired- Max flow for recirc	$68,000,000	$1,448,000
Coal-fired - Avg flow for Top 1/3 of once through systems	$6,000,000	$1,448,000
Nuclear - Max flow for recirc	$143,000,000	$1,448,000
Nuclear - Avg flow for Top 1/3 of once through systems	$16,000,000	$1,448,000

Restoration References

National Oceanic and Atmospheric Administration, April 1999, *Habitat Equivalency Analysis: An Overview*, Damage Assessment and Restoration Program, NOAA, Silver Spring, Maryland.

National Oceanic and Atmospheric Administration, August 1996, *Primary Restoration Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*, Prepared for NOAA's Damage Assessment and Restoration Program. Silver Spring, Maryland. Prepared by EG&G Washington Analytical Services Center, Inc.

Personal communication between Todd Doley of SAIC and Russell Bellmer of NOAA, May 18, 2000.

Personal Communication between Todd Doley of SAIC and the fish restocking service (Fish Wagon 1-800-643-8439) on May 22, 2000.

D. DRAFT BIOLOGICAL MONITORING COSTS

The following draft initial cost estimates for biological monitoring were not derived from cost modeling exercises, but rather represented cost estimates provided by contractors with experience in impingement/entrainment monitoring. A consensus of these experts formed the basis for these draft cost estimates. The draft cost estimates differ depending on the type of waterbody being sampled (with the exception of impingement monitoring). For example, the equipment, effort and expertise needed to sample an ocean facility would be more costly than that needed to monitor a facility located on a stream or small river.

<u>SOURCEWATER BASELINE CHARACTERIZATION (as described at proposed 40 CFR 125.86 (65 Fed. Reg. 49119)</u>

Freshwater stream/river -- $8,000 to 25,000
Lake/reservoir -- $8,000 to 35,000
Estuary/tidal river -- $8,000 to 50,000
Ocean -- $8,000 to 70,000

<u>BIOLOGICAL MONITORING - ENTRAINMENT (as described at proposed 40 CFR 125.87 (65 Fed. Reg. 49121)</u>

Freshwater stream/river -- $15,000 to 40,000
Lake/reservoir -- $15,000 to 40,000
Estuary/tidal river -- $20,000 to 50,000
Ocean -- $20,000 to 50,000

<u>BIOLOGICAL MONITORING - IMPINGEMENT (as described at proposed 40 CFR 125.87 (65 Fed. Reg. 49121)</u>

Freshwater stream/river -- $10,000 to 25,000
Lake/reservoir -- $10,000 to 25,000

Estuary/tidal river -- $10,000 to 25,000
Ocean -- $10,000 to 25,000

DRAFT LIST OF FACILITIES WITH DRY COOLING TECHNOLOGY
MAY 2001

Description: This table provides technical data on existing plants that use dry cooling installations by GEA Power Cooling Systems, Inc., the largest manufacturer in the US.

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Neil Simpson I Station Black Hills Power & Light Co. Gillette, WY	20	168,000	4.5	75	1968	Coal Fired Plant
Norton P. Potter Gen. Station Braintree Electric Light Dept. Braintree, MA	20	190,000	3.5	50	1975	Combined Cycle
Benecia Refinery Exxon Company, U.S.A. Benecia, CA	NA	49,000	9.5	100	1975	
Wyodak Station Black Hills Power & Light Co. and Pacific Power & Light Co. Gillette, WY	330	1,885,000	6.0	66	1977	Coal Fired Plant
Beluga Unit No. 8 Chugach Electric Assoc., Inc. Beluga, AK	65	478,000	5.6	35	1979	Combined Cycle
Gerber Cogeneration Plant Pacific Gas & Electric Gerber, CA	3.7	52,000	2.0	48	1981	Cogeneration
NAS North Island Cogen Plant Sithe Energies, Inc. Coronado, CA	4.0	65,000	5.0	70	1984	Cogeneration
NTC Cogen Plant Sithe Energies, Inc. San Diego, CA	2.6	40,000	5.0	70	1984	Cogeneration
Chinese Station Pacific Ultrapower China Camp, CA	22.4	182,000	6.0	97	1984	Waste Wood
Dutchess County RRF Poughkeepsie, NY	7.5	50,000	4.0	79	1985	Waste to Energy (WTE)

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Sherman Station Wheelabrator Sherman Energy Sherman Station, ME	20	125,000	2.0	43	1985	Waste Wood
Olmsted County WTE Facility Rochester, MN	1	42,000	5.5	80	1985	WTE
Chicago NW WTE Facility City of Chicago Chicago, IL	1	42,000	15 PSIG	90	1986	WTE
SEMASS WTE Facility American Ref-Fuel Rochester, MA	54	408,000	3.5	59	1986	WTE (hybrid cooling system since 1999)
Haverhill Resource Rec. Facility Ogden Martin Of Haverhill Haverill, MA	47	352,000	5.0	85	1987	WTE
Hazelton Cogen Facility Continental Energy Associates Hazelton, PA	68	420,000	3.7	47	1987	Cogen
Grumman TBG Cogen Bethpage, NY	13	106,000	5.4	59	1988	Cogen (hybrid cooling system since 1997)
Cochrane Station Northland Power Cochrane, Ontario, Canada	11	90,000	3.0	60	1988	Cogen
North Branch Power Station Energy America Southeast North Branch, WV	80	622,000	7.0	90	1989	Coal Fired Plant
Sayreville Cogen Project Intercontinental Energy Co. Sayreville, NJ	100	715,000	3.0	59	1989	Cogen
Bellingham Cogen Project Intercontinental Energy Co. Bellingham, MA	100	715,000	3.0	59	1989	Cogen
Spokane Resource Rec Facility Wheelabrator Spokane Inc. Spokane, WA	26	154,000	2.0	47	1989	WTE

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Exeter Energy L.P. Project Oxford Energy Sterling, CT	30	196,000	3.0	75	1989	Hybrid cooling system
Peel Energy From Waste Peel Resources Recovery, Inc. Brampton, Ontario, Canada	10	89,000	4.5	68	1990	WTE
Nipigon Power Plant Transcanada Pipelines Nipigon, Ontario, Canada	15	169,000	3.0	59	1990	Cogen
Linden Cogeneration Project Cogen Technologies, Inc. Linden, NJ	285	1,911,000	2.44	54	1990	Cogen
Maalaea Unit #15 Maui Electric Company, Ltd. Maui, Hawaii	20	150,000	2.5	55	1990	Cogen
Norcon - Welsh Plant Falcon Seaboard North East, PA	20	150,000	6.0	95	1990	Cogen
University of Alaska University of Alaska, Fairbanks Fairbanks, AK	10	46,000	6.0	82	1991	Cogen
Union County RRF Ogden Martins of Union County Union, NJ	50	357,000	8.0	94	1991	WTE
Saranac Energy Plant Falcon Seaboard Saranac, NY	80	737,000	5.0	90	1992	Cogen
Onondaga County RRF Ogden Martin of Onondaga Co. Onondaga, NY	50	258,000	3.0	70	1992	WTE
Neil Simpson II Station Black Hills Power & Light Co. Gillette, WY	80	548,000	6.0	66	1992	Coal Fire Plant
Gordonsville Plant Mission Energy Gordonsville, VA	100	698,000	6.0	90	1993	Combined Cycle

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Dutchess County RRF Expansion Poughkeepsie, NY	15	50,000	5.0	79	1993	WTE
Samalayuca II Power Station Comision Federal de Electricidad Samalayuca, Mexico	210	1,297,000	7.0	99	1993	Combined Cycle
Potter Station Potter Station Power Limited Potter, Ontario	20	182,000	3.8	66	1993	Combined Cycle
Streeter Generating Station Municipal Electric Utility City of Cedar Falls, Iowa Cedar Falls, Iowa	40	246,000	3.5	50	1993	PAC System
MacArther Resource Rec. Facility Islip Resource Recovry Agency Ronkonkoma, New York	11	40,000	4.8	79	1993	WTE
North Bay Plant Transcanada Pipelines North Bay, Ontario, Canada	30	245,000	2.0	53.6	1994	Combined Cycle
Kapuskasing Plant Transcanada Pipelines Kapuskasing, Ontario, Canada	30	245,000	2.0	53.6	1994	Combined Cycle
Haverhill RRF Expansion Ogden martin Sys. of Haverhill Haverhill, MA	46.9	44,500	5.0	85	1994	WTE
Arbor Hills Landfill Gas Facility Browning -Ferris Gas Services,Inc. Northville, MI	9	87,000	3.0	50	1994	Combined Cycle
Pine Bend Landfill Gas Facility Browning - Ferris Gas Services,Inc Eden Prairie, IN	6	58,000	3.0	50	1994	Combined Cycle
Pine Creek Power Station Energy Development, LTD Pine Creek, Northern Territory, Australia	10	95,000	3.63	77	1994	Combined Cycle

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Cabo Negro Plant Methanex Chile Limited Punta Arenas, Chile	6	74,500	4.0	63	1995	Methanol Plant
Esmeraldas Refinery Petro Industrial Esmeraldas, Ecuador	15	123,000	4.5	87.3	1995	Combined Cycle
Mallard Lake Landfill Gas Facility Browning - Ferris Gas Services Inc. Hanover Park, IL	9	101,000	3.0	49	1996	Combined Cycle
Riyadh Power Plant #9 SCECO Riyadh, Saudi Arabia	428	3,867,000	16.5	122	1996	Combined Cycle (1200 MW Total)
Barry CGP Project AES Electric Ltd. Barry, South Wales, UK	100	597,000	3.0	50	1996	Combined Cycle
Zorlu Enerji Project KORTEKS Bursa, Turkey	10	84,000	3.5	59	1997	Combined Cycle
Tucuman Power Station Pluspetrol Energy, S.A. El Bracho, Tucuman, Argentina	150	1,150,000	5.0	99	1997	PAC System
Dighton Power Project Dighton Power Associates, Ltd. Dighton, MA	60	422,000	5.5	90	1997	Combined Cycle
El Dorado Kiewit Industrial Company Boulder, NV	150	1,065,000	2.5	67	1998	Combined Cycle
Tiverton Power Plant Tiverton Power Associates, Ltd. Tiverton, RI	80	550,000	5.0	90	1998	Combined Cycle
Coryton Energy Project Intergen Corringham, England	250	1,637,000	2.5	50	1998	Combined Cycle

Station Owner	Steam Size [Mw(e)]	Steam Flow [lb/Hr]	Turbine Back P [IN HgA]	Design Temp [deg F]	Year	Fuel(s)
Rumford Power Project Rumford Power Associates, Ltd Rumford, ME	80	546,000	5.0	90	1998	Combined Cycle
Keelung RRRP EPA, ROC Keelung City, Taiwan	25	161,000	5.3	89.6	1999	WTE
Lih-Tser RRRP EPA, ROC Yi Lan County, Taiwan	25	154,000	5.3	82.4	1999	WTE